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Hemming, Frederick H

Cheap railroads for India and the colonies in connection with traction engine and endless railway.

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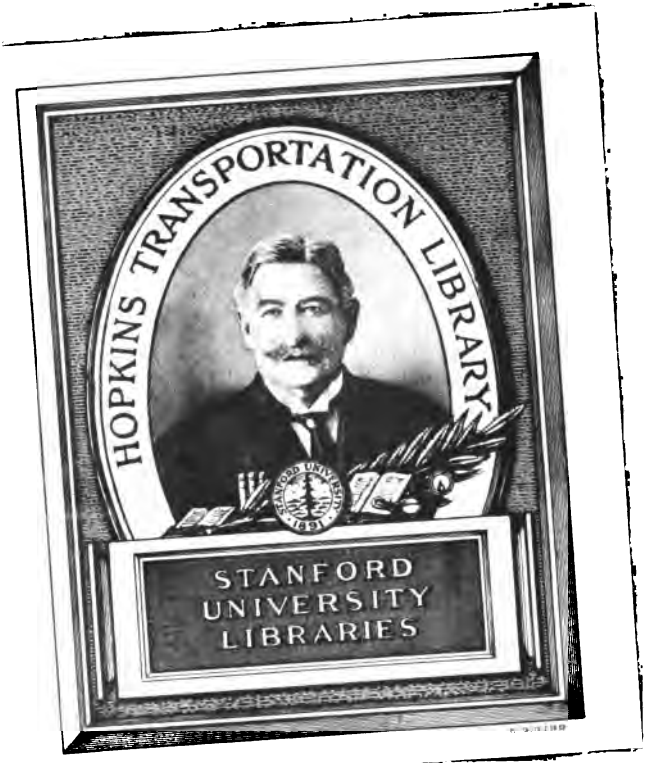

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CHEAP RAILROADS

FOR

INDIA AND THE COLONIES,

IN CONNECTION WITH THE

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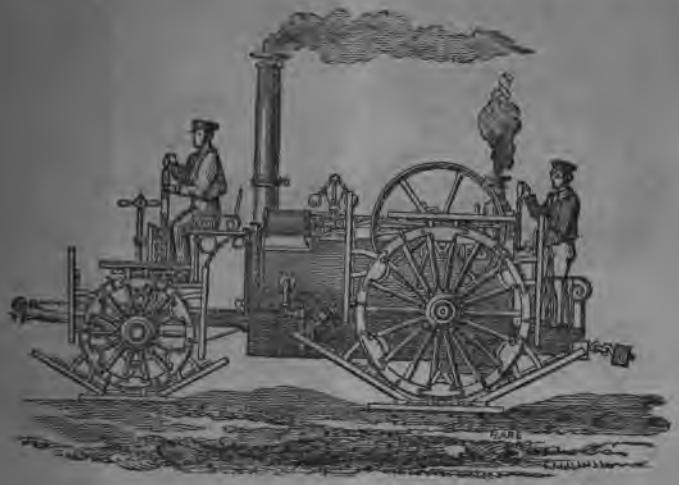

INVENTED AND PATENTED BY JAMES BOYDELL, CAMDEN WORKS, CAMDEN TOWN.

BY

FREDERICK H. HEMMING.

"Speed in forming concentrations is of more importance to India, than speed in travelling on them."—COLONEL CHESNEY.

"The time has arrived when the power of transporting compact and highly trained bodies of European troops from one point of India to another may be all-important."—*Times, June 27, 1857.*

LONDON:
EFFINGHAM WILSON, ROYAL EXCHANGE.
Price One Shilling.

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FOR

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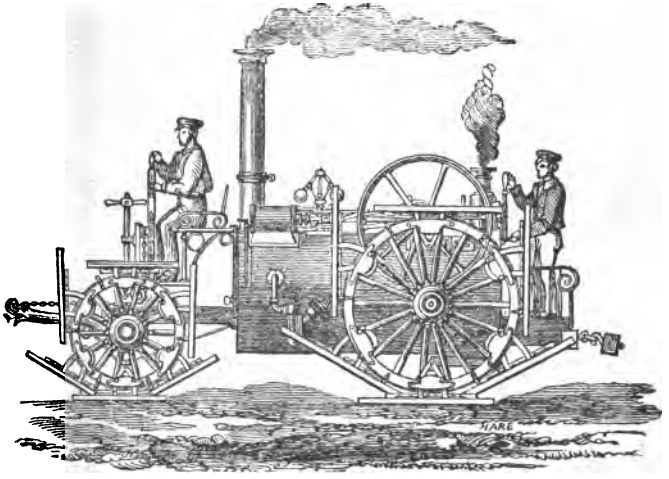

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CHEAP RAILROADS FOR INDIA AND THE COLONIES,

IN CONNECTION WITH THE

TRACTION ENGINE AND ENDLESS RAILWAY.

ERRATUM.

Page 25, last line but one, after "twenty teeth," *read* "on the same shaft with one of ten teeth."

might bring to bear upon, the construction and working of a system of cheap Railroads generally, in those parts of the world where they are most required, while in many cases it would supersede their necessity altogether.

My attention was the more specially directed to this subject from the circumstance of my having been the Secretary to two Railroad Companies in the North of Ireland connected with the city of Londonderry, for ten years previously, during which time I had spent nearly the half of each year in giving my personal assistance on the spot, in carrying on the traffic on those two lines.

Every month's further acquaintance with the extraordinary powers and capabilities of this invention have tended not only to confirm, but to increase the opinion I at first formed, as to its bearing on the subject now suggested, when my

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attention was forcibly arrested by the appearance of the Prospectus of the North of India Tramroad Com-any, which I read with very great interest. Anxious for further information, I called at the office of the Company, when I was kindly presented by the Secretary with a copy of a pamphlet entitled "TRAMROADS in NORTHERN INDIA, in connection with the IRON MINES of KUMAON and GURHWAL," by W. P. Andrew, Esq., who is Chairman of the proposed "NORTH of INDIA TRAMROAD COMPANY," as also of other Railways in India now in course of construction.

The attentive perusal of this book, and an interview with which I was afterwards favoured by Mr. Andrew himself, has decided me in thus bringing before the public the result of the consideration which I have given to this subject, and if I should prove instrumental, even in the humblest degree, in furthering objects of such paramount interest, I shall have pleasure in feeling that my time and trouble have not been bestowed in vain.

In the observations I am about to make I shall take the pamphlet before mentioned as my text-book, not with the intention, even where I may differ in opinion, to criticise it, but to avail myself of the valuable information afforded by one who evidently possesses so much general and local knowledge on the subject of which it treats; and also of data obtained from reliable sources to which I have not equal access.

On first reading the Prospectus of the "NORTH of INDIA TRAMROAD COMPANY," I made exactly the same observation as to the "TRACTION ENGINE and ENDLESS RAILWAY," in reference to cheap Railways in India, and nearly in the same words,—although I had not then read his book,—as that made by Mr. Andrew, in reference to the important discovery of iron, that "This invention appears most opportunely, at

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the time when it is most required, and is one of those providential circumstances which resembles in importance the valuable gold discoveries in Australia and California."

As I shall have so frequently to refer to the peculiar characteristics and merits of the "TRACTION ENGINE and ENDLESS RAILWAY," I shall probably create doubts in the minds of many of my readers as to the possibility of any one implement being applicable to so many different purposes, and under so many different circumstances, which doubts may also be further increased, when I avow my peculiar connection with this undertaking, being the Secretary to a public company now forming, for bringing into extended operation this extraordinary invention. But I have only to ask those who doubt, to avail themselves of the opportunity now offered of judging for themselves, when I have no doubt of their coming to the same conclusions as I have done.

"Cheapness in construction and also in the working of Railways" must always be most essential features, for whatever purposes and in whatever country they may be introduced; but the dictum of Colonel Cotton, that "speed in forming communications is of more importance to India than speed in travelling on them," appears to be adopted not only by Captain Yule and Mr. Strachey, who must be considered valuable authorities, but also to be acquiesced in by all who have expressed any opinion on the subject.

My object will now be to show, that to carry out the plan proposed by the North of India Tramroad Company, of connecting Shahjehanpoor with Delhi by a main line, having branches to Futtygurh, Philibeet, and Nugeena, a thoroughly efficient railway may be constructed at little more than half the estimated cost—in considerably less than half the estimated time, and may be worked with far more efficiency and economy, at the same time providing for the whole of

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the goods traffic a greatly increased speed beyond the improvement therein contemplated.

The general idea at present propounded appears to be to save time, in the first instance, by constructing a railway comparatively light and inexpensive, to be hereafter converted into one of a more solid and permanent character, as the increase of traffic, and other circumstances, may concur to render necessary. This is all very well in theory, but I very much question as to its being practically carried out to advantage; and I believe that the more advisable course, and one that would prove the most economical, would be at first, to form a line of a still more temporary character, without, however, in any way diminishing its efficiency for the purposes now required, which would, at all events, have this important advantage, in being able to make it in less than half the time. In endeavouring afterwards to transform the lighter into a more solid line, how much of the first construction would be available for the purpose? The rails, the most expensive part of the whole, would be useless, excepting to be removed, to open in a similar manner some new line of country. The timber, which, either for a temporary or a permanent line, must in time decay, would scarcely be in such a state at the end even of a few years, as to make it prudent to adopt it in the construction of a permament line, which would so soon require its renewal.

The great difficulty—until iron in sufficient quantities can be procured from the mines in India—which, under the most favourable circumstances, must be a very considerable time—is the cost of the rails, when delivered on the spot, and the length of time it would take to supply freight for the requisite quantity from England. To meet this difficulty, it is proposed by the North of India Tramroad Company to use a rail of 35lb. to the yard, instead of, I presume, about 70lb. Even at

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the comparatively light weight of 35lb. a-yard it will take 55 tons a-mile, and the 302 miles with which it is proposed to commence, will consequently require 16,600 tons, to which it will be necessary to add 10 per cent. for sidings, stations, &c., making a total of 18,200 tons of rails only. This, at the estimate of £16 per ton, will cost £880 per mile, making a total, with the sidings, &c., of £292,000.

By my plan I propose to use only 12 tons of rails to the mile, which will require a trifle under 4,000 tons, at a cost, by the same estimate, of rather less than £64,000, thereby effecting a saving in the tonnage and freight of above 14,200 tons, being seven-ninths of the whole quantity, and a saving in the cost of the rails alone of £228,000, being nearly one-fourth of the whole estimated capital.

It is needless to urge the importance of such a reduction in the necessary expenditure for that portion of the line alone at the very outset of the undertaking, but I adopt the words of Mr. Sowerby, in his report of April 3rd, 1857, (page 19, line 27): "It is not, however, so much in a reduction of the cost of the iron that should be looked forward to, as the greater facility that will be afforded for the more rapid completion of the works, by avoiding *those delays which are due to the transport of the materials* from England." Mr. Andrew also quotes from "Friend of India," January 25, 1855, (p. 45, l. 12): "At present there is no prospect of procuring their supplies excepting from England, and *the difficulty of obtaining a sufficiency of freight* for the conveyance of the iron appears to be the greatest obstacle to success."

The estimate of time necessary to complete the "North of India Tramroad" appears to be (p. 15, l. 12), "in about three or four years," during which time it would be necessary to procure freight for the rails alone to the extent of 18,200

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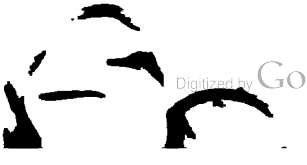
tons. If, therefore, the necessary freight be reduced to 4,000 tons for the same purpose, it is evident that it may be easily obtained in less than one year; and I do not see anything to prevent the main line at least being opened in one year-and-a-half from the period of its commencement.

It may be supposed, from the great reduction I suggest, both in the cost of construction, and the time for completion, that I am about to propose a line of railway inferior in its use and object; but I feel fully convinced, that taken in conjunction with the proposed method of working it, while it obtains those two most important advantages, and especially that grand desideratum, "speed in forming communication in India," (for it will be equally applicable to every part of that vast empire where timber abounds or is easily obtained)—it will, as I stated before, "be worked with far more efficiency and economy, providing for the whole of the goods traffic a greatly increased speed over the improvement contemplated" in the prospectus of the North of India Tramroad Company.

I rely, of course, on the statement put forth in the prospectus (p. 14, l. 32) that "the construction of the Tramroad will be *rendered cheap*, by *reason of the facility* for drawing timber in any quantity from the adjacent dense forests at the foot of the Himalayas," and also in Mr. Sowerby's report, (p. 20, line 18), that "the timber intended to be used both in the permanent way, and in the bridges, can be procured in unlimited quantities" from the same source.

I observe that it is intended to work the Tramroad, partly "by animal power, in the first instance, until the traffic becomes more developed" (p. 14, l. 24), and partly "by a very light description of locomotive engines" (p. 27, l. 24).

Now, whatever objection there may be to the former, or difficulty, either in procuring or in making the permanent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way sufficiently heavy for the latter—by themselves—I believe the mixture of the two systems, however satisfactory in theory, to be open to many and grave objections in practice. To these I may recur hereafter, but will, for the present, confine my observations to the use of "animal power."

I do not quite make out what description of animal is intended to be used. At p. 11, l. 25, I see that "oxen and elephants" are at present used on the route of the proposed Tramroad. In another place "camels" appear to be in use; and at p. 35, l. 6, I see that they intend to avail themselves both of "oxen and ponies"—the former being only able to accomplish twelve miles a-day. I observe (p. 14, l. 12) that, whereas "the present rate of travelling in India, by camels and carts, seldom amounts to 80 miles a-week," they propose, in lieu thereof, at once to obtain a speed of 80 miles a-day. I presume, therefore, from that, and also from Mr. Murray's report (p. 31), "on the application of horse-power to railways" that the animal mostly relied on for working this species of railways is the horse.

Now, in the place of each and all of these, I propose to substitute the "STEAM HORSE;" or, in other words, the "TRACTION ENGINE and ENDLESS RAILWAY."

It is true, as stated by Mr. Murray (p. 35, l. 22), that "horse-power is effective on a rise, where locomotives are inapplicable," because a horse could go up an ascent, with a load proportionate thereto, where a locomotive could not even take itself up; but, as with locomotives so with horses, the load must have reference to the gradient they have to ascend. I gather that there are some varying gradients on the proposed line, although not of sufficient importance to render necessary any engineering contrivance to overcome them.

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The construction of the "TRACTION ENGINE and ENDLESS RAILWAY" provides that, for general use, a certain speed is maintained with a given load on moderate gradients, for which it is fully capable; but, in case of meeting with any unusual obstruction, or having to ascend a very steep incline, the gearing may be so altered that a double power of traction is given, although at the expense of speed, which for the time is proportionably diminished. This temporary loss of speed is, however, of very little importance, compared with the great advantage of thus overcoming the difficulty of occasional severe gradients, and is only an exemplification of the custom, in the olden time, of stage coaches, when with four horses capable of maintaining an average speed of nine or ten miles an hour on ordinary roads, they were obliged sometimes to walk them up a steep hill, instead of stopping at the bottom to put on an extra pair of horses, to enable them to accomplish the same object in a trot.

The ordinary speed I propose for the goods traffic on the railway is 5 miles an hour, which in the 24 hours would perform 120 miles; but I allow four hours out of the twenty-four for stoppages, taking in water, fuel, &c., which would enable them easily to accomplish 100 miles, being one-fourth more than that which is contemplated by the North of India Tramroad Company, and would be, proportionably, "a greater boon conferred upon India."

Mr. Murray also says in his report (p. 85, l. 24), "On a descent, the horse obtains much relief from the effect of gravity." This is very true; but all who have been in the habit of seeing horses employed on railways will bear witness to the great danger to which they are exposed in descending gradients with a load behind them—a danger from which they are not altogether free even on perfectly level lines. In descending an incline, horses are much more liable to

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stumble and fall; and with all the caution you can exact from the drivers, and the difficulty of checking the momentum of the waggons, many are killed in this manner, and waggons are not unfrequently thrown off the line; and when you consider the immense number of horses which must be in constant use to draw loads, in remunerating quantities, on a railroad of any description, it is an evil of no trifling importance. From the possibility of any such occurrence, the "steam horse" is at all times free, because any load that he can draw up a hill, he can with ease hold back in going down the same, without any break being applied to any of the waggons. This latter power was strongly exemplified at Woolwich, in some experiments made with one of these engines, before a Committee appointed by the Government, and presided over by Colonel Tulloh, in June, 1856, when a heavy siege gun, weighing 5 tons 12 cwt., making, with the gun-carriage, &c., a total weight of nine tons—having been drawn by the Traction Engine from the Arsenal, up Burrage-road to Plumstead-common, with a gradient of 1 in 10; was taken down the steep incline, to Waterman's-fields in return, having a gradient of 1 in 8; and is thus described in the *Mark Lane Express* of that date—"Of the two, descending was considered the master-part of this experiment, no break or drag being upon any of the wheels—those of the gun-carriage and tender (9 tons) being without endless rails; for, on the very steepest part of the inclination, our modern Megatherium war-horse had as much control over his ponderous load, as is to be seen in the parallel case of the steam hammer, standing rock fast, like a statue, the instant the order, 'Stop her!' was given; a feat which even few of the admirers of this new-fangled innovation expected to see performed in so triumphant a manner."

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Before quitting the subject of the use of horses on the railway, I would point out what I conceive, under any circumstances, to be a very serious, and in some instances to be an almost insurmountable, obstacle to the working of the line by such means. I allude to the great difficulty of keeping the permanent way in working order during the rainy season, which I have been informed lasts for about three months. We all know the difficulty of doing this, even in England, where there is an alternation of wet and dry weather, and where we have the best materials in abundance for the purpose, "with all appliances and means to boot," whereas we learn from Mr. Strachey (p. 9, l. 33): "Through the greater part of Rohilcund there is little *kunkur* to be found, and there is no other material available for metalling roads." Under such circumstances—with the horses' feet acting as so many ploughs, the road between the rails must soon become a perfect ditch, and before long totally impassable, and this, in addition to the increased difficulty it must create in keeping the rails themselves in anything like working condition.

The same objection is not chargeable against the "steam horse" in consequence of the great surface of his shoe, which if necessary, may be still further and temporarily increased for this special purpose, and from the peculiar manner in which he puts his foot down, and lifts it from the ground. On the contrary, I believe that in most cases its use would absolutely improve the road, especially if, in anticipation of the rainy season, brushwood were spread along in the track of the shoes, which never touch the rails, the wheels of the engine which carry them keeping, one between and the other on the outside of the rails.

By this use of brushwood, judiciously applied for the wet season, I believe you would maintain a most valuable drainage

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for the time being, at a very trifling cost, and at the end of that time, on the arrival of dry weather, the permanent way would be easily and cheaply put and kept in order for the remainder of the year. It would also, from affording so much better foothold for the "steam horse," enable him to do as much work in the wettest as in the dryest season, should such be required of him.

Having thus shown how and why I would substitute the "steam horse," for (in the words of the Old Turnpike Acts) "horse, ox, ass, mule, or other animal," I proceed to show how and why, in like manner, I would substitute him for locomotives; (and for this purpose I shall adopt his proper designation of "The Traction Engine"), on lines such as that proposed to be adopted by the North of India Tramroad Company.

On this part of the subject there appear to be considerable misgivings in the minds of the promoters as to the practicability, or at all events as to the period when it might be either possible or prudent, to introduce locomotives on their lines; so much so, that I think they will scarcely object to abandon them altogether, when they see how much may be obtained without them, and at such an immense saving in the first outlay.

In their prospectus (p. 14, l. 28) they say, "as the traffic increases, light locomotives *may be used* with a moderate speed. Some portions of the line, however, *will be adapted* for light locomotives from the commencement." In Mr. Sowerby's report on the execution of the works, after stating (p. 24, l. 10) that "he had prepared an estimate for a portion of the line of a more substantial character, with rails of 50 lbs. a yard, and adapted to light locomotives of about 9 to 12 tons weight, running at speeds of from 10 to 20 miles per hour," he says, "it is proper here to explain that in

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laying this portion of the line of a character adapted for light locomotives, *it is not, therefore, intended* necessarily, that locomotives should be used *from the commencement*, but only *gradually introduced* from time to time as they could be obtained; the traffic, in the meantime, being worked by animals, precisely as was done originally on the Stockton and Darlington, and other English and Foreign Railways at their commencement—a few locomotives only being used, after the lines had been opened several years, and then only used for particular purposes."

I fear, also, that they have greatly overrated the power of locomotives, even if they could procure them without difficulty, and had a line of rail sufficiently heavy to carry them. In Mr. Sowerby's report of "The working of the Line," he says (p. 27, l. 27): "The weight of such engines as I should recommend would be from 9 tons to 12 tons, and capable of drawing loads from 50 tons to 250 tons net, exclusive of the waggons, at speeds of from 10 to 20 miles an hour. Captain Yule estimates that a 14-ton engine is capable of drawing 80 tons net; but I believe that this estimate is very much too low, and that 300 tons would be much nearer the truth."

Where there is so wide a difference in the estimates, "*in medio tutissimus*" might generally be a safe maxim to adopt, but I should rather incline even from this towards Captain Yule's estimate than to the higher one, for the probable result when carried out on such a line as that proposed. This opinion is strengthened by a reference to a "Gravity Diagram," for showing the power of locomotives on varying gradients, made by a gentleman with whom I was formerly associated on the Londonderry railways—Mr. Arthur William Forde—for the "Bombay, Baroda, and Central India Railway Company," of which he is now the Chief Engineer in India,

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and is to be found in Colonel Kennedy's valuable publication, "The Principles of Railway Construction Analysed." (See appendix A.) I there find that an engine and tender, weighing 35 tons—being three times the weight proposed for the North of India Tramroad Company, even on a gradient of 1 in 500, which must be admitted to be a very favorable one —is only calculated to draw 245 tons net, at the rate of 20 miles an hour, and that under "conditions" which, excepting for the purposes of an experiment, are scarcely ever met with —namely, "a good sound road, a straight road, an average side-wind—engine and train in good working order." At the reduced speed of 15 miles an hour, the 35-ton engine would only draw 270 tons net.

Among the various purposes for which "The Traction Engine and Endless Railway" has hitherto been applied, having reference principally to agriculture and to ordinary road traction, its application to railways, as now in use, had scarcely been suggested, and we have therefore no actual test of its full powers upon the different gradients on existing lines, or to the greatly-increased gradients which, under peculiar circumstances, may hereafter be adopted, which "The Traction Engine" is capable, either directly or indirectly, of overcoming.

By the kindness of the Officers of the South-Eastern Railway, we were afforded an opportunity of making an experiment on Wednesday, June 10th, which left no doubt on the minds of all who saw it, as to its practical utility on a rail, where power, and not speed, is required. The engine was travelling by the road, taking its own agricultural implements with it, on its way from Thetford, in Norfolk, and Saffron Walden, in Essex, at both of which places it had been ploughing, to perform similar duties at Farningham, in Kent, and in passing the Bricklayer's Arms Station of the South-Eastern Railway,

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we were permitted to take it in there for the trial in question.

The engine has 7-inch cylinders, and a 6-feet driving-wheel. On its arrival in the station, it placed itself in the proper position for drawing, having two wheels between the rails, and two on the outside, and was attached to a train of 23 passenger carriages, weighing 86 tons, which it moved with so little exertion that we suggested to have some more added, which was done. We then had 35 passenger carriages, some of them with six wheels, weighing 138½ tons. The train was 270 yards long, and at about two-thirds of the distance from the engine, there was an S or reverse curve. All the carriages were coupled closely together, as when used for an express train, and the engine drew the whole train from a state of perfect rest, with little more than half the steam employed.

The "Traction Engine and Endless Railway," complete, which I propose to use for the goods traffic at the rate of 5 miles an hour, has 7-inch cylinders and 7-feet driving wheels, weighs about 8 tons empty, and about 10 tons with coals and water. For the passenger trade, I propose an engine which, from having larger wheels, would travel at the rate of 8 miles an hour, but would not be much heavier than the other. As there probably would not be sufficient passenger traffic to employ the full power of these engines, the spare power would be profitably employed in drawing a certain amount of goods at this increased speed, for which purpose goods' waggons more assimilated to those now in use than those which I propose for the bulk of the goods traffic, would be neccessary; and I may here add that my proposed railway would be fully capable of bearing all the ordinary rolling stock of the trunk lines, with the exception of the locomotives. Mr. Murray, in his report on "Horse Power," concludes with

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these words: "Locomotives would have to be brought from England, and on their arrival in the country, would have to be conveyed a long distance into the interior at a great expense." The high price of locomotives in England is well known—the freight, from their unwieldly character, is necessarily very high—and if, on their arrival at the port of disembarkation, they are unable to steam themselves to their ultimate destination, the cost of transit, from the same cause, must prove a most serious addition to the prime cost.

The Traction Engine is open to none of these objections, excepting that they must come from England. The prime cost, as compared with locomotives, having reference to the power and utility of both, is, out of all proportion, low. The weight being only 8 tons, which may be divided for the purposes of stowage, the heaviest piece being only about 4 tons, the freight would be more than proportionably low; while that which is one of the greatest drawbacks, "the conveyance of locomotives a long distance into the interior at a great expense," is not only overcome, but a positive benefit substituted in its place. On its arrival in India, the Traction Engine is put together in a few hours, and is ready to start on its journey to the interior, drawing with it as much as will more than pay the whole expense of its own transit.

Another very great advantage arising from the use of the "Traction Engine and Endless Railway" in the place of either animal power or ordinary locomotives, and more especially from a mixture of the two, is the avoiding the danger, to which I alluded in a former page, of collision, and consequent injury to person and property. With the "Traction Engine," collision, unless wilfully brought about, is all but impossible; and hence a very great saving may be made in the construction of the goods waggons, which need not be either so strong or so heavy as those generally in use.

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Any person who has watched a goods train starting from a station on an English railway, cannot fail to have observed the tremendous jerk given to every waggon, as the chains by which it is attached to its precursor successively become tightened, and also the concussion every time the train stops, which being so constantly repeated, must greatly increase the wear and tear of that portion of the rolling stock.

This, although a very serious evil, cannot altogether be avoided, as from the want of adhesion on the rails, the locomotive, in starting with a heavy train, would always slip, unless allowed to acquire a certain amount of impetus before any very large portion of the train was set in motion; but all this is avoided in the use of the Traction Engine, which, from the great hold it has on the ground, is enabled to apply its whole force at once, but in so gentle a manner, that the whole train is set in motion simultaneously, and at so moderate a pace as scarcely, at first, to be perceptible. This was particularly remarked by those who witnessed the experiment on the rails at the Bricklayers' Arms Station. Taking advantage of this peculiarity, and considering the pace at which it is proposed to travel, I believe that buffers would be, not at all, and springs scarcely, necessary for the goods waggon, and that the wheels may be entirely of cast iron, considerably smaller and therefore lighter and less expensive, than those used in England. I believe, also, that it would be better to attach the wheels as on ordinary road waggons, and not to have them fixed on the axle, which makes it more difficult to repair any damage by accident or otherwise. The axle being fixed to the body of the waggon, and strengthened by the framing thereof, need not be so large and heavy, and the wheels and axles being detached, are more convenient for stowage and freight, which would, in addition to the proposed reduction in the size of both, consequently reduce this important item of expenditure.

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Viewing all these elements of economy, and thus lessening the wants to be supplied from England, it appears to me that a very large portion of the working plant would be procured very quickly, and at comparatively a very low cost.

The last advantage I shall mention, though not the least in importance, is the great assistance to be obtained from the Traction Engine in case of accident occuring to the train from waggons getting off the line, or from other causes, which, considering the thinly-populated districts through which the train has sometimes to travel, and the absence of all other aid, might have most serious importance. Suppose a train of 20 or 30 waggons, drawn by a locomotive, and some of those in the rear or middle of the train are thrown off the line. The only assistance the engine could give, would be to draw the other waggons out of the way, but it could not pass by them to render further help. With horses, although they be taken to the exact spot required, there would not often be power enough to render effectual assistance, whereas the traction engine, taking the front waggons out of the way, could do the same with those in the rear, and then bring its whole force to bear at the spot required, so that there are few casualities in which, with the aid of an intelligent guard, driver, and steerer, the engine itself could not provide the necessary relief. All other resources failing, it would either take a portion of the train on to the next station or back to the one they had previously left, as the greater proximity to either might render advisable.

In thus showing how the "Traction Engine and Endless Railway," by which I can obtain 8 miles an hour for passengers, and 5 miles an hour for the goods traffic, may be substituted in the place both of animal power and ordinary locomotives, I trust I have said enough to induce the promoters of cheap tramroads in India to pause and consider

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whether it is not more prudent, economical, and advisable in every way to adopt railways of a still more temporary construction, especially when they can be introduced in so much shorter time, until, by being able to procure their rails from the "iron mines of Kumaon and Gurhwal," and in the meantime, partially to develope their traffic, they may be enabled to make railroads of a more permanent character, in unison with the other trunk lines now being constructed in that empire, to be worked with locomotives correspondent with the traffic.

It must, however, always be borne in mind that the formation of the earthworks for the temporary line will become consolidated, aud always available for the permanent one, when required—at which time the iron and such timber as may not then be too much decayed, may be used either for similar purposes or in making branches to feed the trunk lines.

It may be thought that, in going so fully into the means of working the line before I make the line itself, I am "putting the cart before the horse," but I adopted this course because the proposed mode of working it could not, from the novelty of the invention which is to take so prominent a part in it, have suggested itself to those who have otherwise bestowed so much attention on the subject, while in the railway, I am going to propose nothing new in principle, but only a modification of that system which has hitherto been found so efficient under similar circumstances.

I am not aware, in the proposed adoption of rails of 35lb. to the yard, whether it be intended to use longitudinal or cross sleepers; if the latter they would scarcely carry locomotives even of the light weights suggested, while for horses the cross sleepers would be very objectionable.

I propose to use longitudinal sleepers, with a bar of iron

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$2 \times \frac{3}{8}$, running down the centre of its surface — having countersunk holes for the screws, the timber being so cut as, with the assistance of the iron bar, to form the rail, and provide for the flange of the wheels, or to be cut flat, and add a strip of hard wood under the iron, of such width and thickness as may be deemed advisable. It would be necessary to have cross sleepers at the joints of the longitudinals (which would not be in the way of the "Steam-horse"), and, probably, in the centre also, which would partially stiffen the line, and serve to keep the whole in gauge. A still cheaper, and scarcely less efficient line, may be made by the longitudinals being cut only six inches square, and the iron screwed to the top of the inner edge. It would require a few more cross sleepers, but each individual piece of timber being so much smaller and lighter, would be found much more convenient, both for handling and for carriage. Such a line, as I have before stated, would only require 12 tons of rails per mile—and worked as I propose, would, I believe, be found admirably adapted to meet the present demand for "speed in forming communications," not only in India, but in every country where timber is cheap and iron dear; and that having special reference to the "rich province of Rohilcund," and to the short time in which such a line could be constructed, its adoption is the best calculated for the object for which the "North of India Tramroad Company" is promoted, namely, "for the preservation of that fine province from decay, and its industrious and tranquil population from ruin."

Having claimed so much consideration for the "steam-horse" in working the line, I am about to do the same for his usefulness in helping to make the line itself. On his arrival in India, as I before stated, he is able not only to transport himself to the interior, but to take a large amount

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of freight with him. He is not, however, doomed to be idle until the line is made, but on his arrival at his ultimate destination, he may be put to work for various and most important purposes.

Under any circumstances, a large quantity of timber will have to be cut down—sawn into the scantlings required, and delivered on the line of railway, all of which the "TRACTION ENGINE" is perfectly able to perform. I observe that mention is made of water-power for saw-mills, &c., and I presume that the ordinary course would be to cut down the timber with the axe, and then draw it to the mills, which must frequently be both a troublesome and expensive operation.

Instead of taking the timber to the mills, I propose that the mills shall take themselves to the timber, and with the use of the proper saw machinery, benches, &c., every engine being placed where it will work to the most advantage, will be able to exert its full power as a stationary engine.

Having cut the sleepers to the requisite dimensions, it can then take them to the place where they are required to be used, without carrying any useless lumber; and the portions of timber cut off serve, at once, on the spot for fuel for the engines, and thus enable them to be worked with the greatest economy.

There is also another very important saving, which may be effected in the construction of the line, by using the Traction Engine, to work it—namely, in making the bridges, of which there appears to be a considerable number. I am not aware exactly how many there may be on the whole of the line proposed by the North of India Tramroad Company, but I observe in Mr. Sowerby's report, (p. 23), that nine are mentioned by name, with an ominous "&c." at the end, besides the two very large ones which will ultimately be necessary in any permanent line, across the Ramgunga and

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the Ganges, but which it is proposed to cross, at present, by different means.

In ordinary cases, it would not be prudent to have the gradients for the ascent and descent of the bridges worse than the ruling gradient on the other portions of the line, in which case it would sometimes be necessary to have very long, and what is still worse, very lofty bridges. This necessity may in some instances be avoided from the power of the Traction Engine to master such severe gradients; a bridge may be constructed at a much lower level, with such inclines on either side of the river, as the nature of the country may require; and while due provision is made against the possibility of their being affected by the highest floods, from being able to take off so much both from their length and height, they will necessarily be far less expensive.

In going down on to the bridge, breaks, if necessary, may be applied to the waggons in the rear; and if, in ascending, the gradient is too steep for the engine to take up the whole train at once, it can take up a part of it at first, and return for the remainder, or make itself a stationary engine on its first ascent, and draw up the rest of the train by a chain or rope.

Even in the modes proposed for crossing the rivers Ranguuga and the Ganges, or in any other way, the engine may be made most useful, either by acting on a chain as suggested, or by walking itself on to a decked flat or scow, where it would, for the time, become a stationary engine, and by means of a band over the fly-wheel work two small screws, one on either side of the stern post and rudder, and having taken itself across the river, it would walk on shore, and be made to apply its power to bring over the train in any way that may be considered the most advantageous.

I have now shown not only how greatly the "Traction

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Engine" can be instrumental in making a railway adapted to the necessities of Northern India, at a greatly reduced cost, over any other plan hitherto projected, but also how it can work it, as I believe, far more efficiently and economically than by horses, or by locomotives, either separately or combined; and I might well be content to rest here in detailing its numerous and important qualifications, but that certainly not the least important of them all, especially in the "*speed of forming communications in India*," remains to be told, which is, that it is able to take the place, and thereby supersede the necessity, of some branch lines altogether.

"THE TRACTION ENGINE and ENDLESS RAILWAY" has been proved by actual experiments to be capable of drawing heavy loads, not only on ordinarily good roads, such as we have in England, but also over very bad roads, and wet marshy ground where no roads exist at all. When passing over good roads, the waggons may have ordinary wheels, but on marshy ground, where such wheels would sink up to the axles, this difficulty is removed by attaching the "Endless Railway" to the wheels of the waggons, by which means the "Traction Engine" can draw almost as much dead weight as on ordinary roads, with ordinary wheels, and wheels are so constructed that they may be used either with or without the "Endless Railway." For its adaptation to all these purposes, we have the most satisfactory testimony, which I proceed to give.

The applicability of the "Traction Engine" for drawing heavy loads on common roads attracted the attention of several gentlemen interested in the numerous collieries in Somersetshire, in the neighbourhood of Bath and Bristol, some of whom took the trouble to go from thence to Thetford, in Norfolk, to witness some public experiments there made on the 7th and 8th of May, with two of these engines, built by Mr. Charles Burrell, of Thetford, partly for plough-

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ing and agricultural purposes, and partly for drawing on common roads. The trials on the road were only made to a limited extent, but as far as they went, were considered so satisfactory by the gentlemen who had gone from Bath to witness them, that they deputed Mr. W. McAdam, a gentleman of high professional standing in the West of England, to accompany a train of waggons, which it was arranged, should be drawn from Thetford to London (80 miles) by one of the engines which was going there to be shipped to the West Indies. In accordance with this arrangement, the "Traction Engine," with its train attached, started from Thetford, on Thursday, May 14th, under the superintendence of Mr. James Boydell, the inventor and patentee, accompanied by Mr. McAdam, who made a report of every particular which occurred on the journey, to those gentlemen at whose express request he undertook it, from which the following extracts are made:—

Journal of a Trial of Mr. Boydell's Traction Engine, on its Endless Railway, from Thetford, in Norfolk, to London, being about eighty-five miles, on Thursday, Friday, and Saturday, the 14th, 15th, and 16th days of May, 1857.

A HIGH PRESSURE ENGINE, on four wheels, with tubular boiler, of ten-horse power, and weighing with water and one cwt. of coals on it, ten tons; having two seven inch cylinders, of one foot stroke each, one drum fly-wheel of four feet diameter.

The two hinder wheels had on the endless railway, and were of six feet diameter to the tyres, both working loose on arms fixed, bracket fashion, to the sides of the fire-box, eighteen inches in length, and four inches in diameter.

The off wheel alone drove the engine by means of a geared cast iron plate-wheel, of five feet in diameter and ninety-six teeth, bolted firmly to four extra-sized spokes.

The single power consisted of a pinion of ten teeth, working on the geared wheel of ninety-six teeth.

The double power consisted of the same pinion working into another of twenty teeth, which worked into the geared plate before mentioned.

The front wheels, which work on a fixed axle, and lock by means of a

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perch bolt, are four feet six inches in diameter. The endless railway was removed from them.

By these front wheels the engine is guided or steered by means of a coach pole, of nine feet in length, and a wheel and rudder chains conducted exactly as it is on board ship, the pole representing the tiller.

The extreme pressure of steam 70 lb. on the square inch. The first point of draught in a direct line with the driving wheel; the second and usual point eighteen inches towards the near side of the engine, both through a strong beam of wood, bolted to the fire-box foot-plate.

An elevating screw, working in the perch bolt, raises or lowers the head of the boilers according to the ascent or descent of the ground, and is easily worked by the steerer. It has sixteen inches of thread. The load consisted of articles which were to have been sent to London by railway, and the train of carriages which contained them was necessarily elongated by the requirements of the General Turnpike Acts, which restrict the weight of goods which shall be placed upon two or four wheels.

The train was 95 feet in length.
The engine 27 „ „
Together 122 feet long.

	Tons.	cwts.	lb.
One timber wagon, 4½ inch wheels	5	7	0
One threshing machine...	2	0	0
One ditto ditto	1	17	0
One wagon, on 2½ inch wheels, containing a spare supply of water (never used), coals, coke, iron castings, &c.	4	0	0
One agricultural engine (which was left at a farm near Newmarket)	8	0	0
Eight people (three of whom were in attendance on the engine, and one on the train)	0	12	0
Chains and heavy attachments to enable the wagons to draw each other	0	5	0
Together	17	1	0

On Thursday morning left Thetford at 10.3; supply of coke 10 cwt. 2 qr. 12 lb., ditto of coals (14 bags) 8 cwt. 2 qr. 24 lb. Tank full of water; one ton spare water. 10.5 a.m. Started. 10.10. Double power on in mistake, reduced to single. First mile up hill, 1 in 24. 11.6. down hill, about 1 in 36, then up 1 in 15; this tried the engine, the driver not being acquainted with her power. 11.15. Stopped to show engine. 11.17. On again. 11.22. Stopped at Elden for water; watered by a draw-well with a small bucket. 12.46. p.m. Started round a right-angled turn in a 23-feet road without any difficulty. 1.15. Stopped for horses. 1.16. Started. 1.43. Stopped for heated driving wheel (a new box had been put in that mornin

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The road had been loose, and made of flints. Stopped for want of steam; coke had been tried, and smothered the fire: it was found to be too slow in burning. Very bad parish road but flat. 3.15. Stopped for water at three quarters of a mile from Milden Hall, Suffolk; cleaned ash pan for first time; crowds of people and many horsemen and some gigs following us, riding and driving close to the engine. 5.30. Steep bad road, over 1 in 18; engine very steady; about 2½ miles an hour; steering beginning to be affected at the inner or No. 2 point of draught, all this time single power used. 6.10. Stopped at "The Red Lodge" Inn; filled up water 3½ miles from Milden Hall; cleaned fire-pan. 6.35. Started from "The Red Lodge;" road very good, dry, hard, and smoth. 7.36. Crossed railway arch up a gradient of 1 in 15, newly stoned with broken flints. The engine went very slowly, but did not stop! would not steer well; tended to the near watercourse, and at last got into it. I stopped the engine to alter the power, when Mr. Boydell desired the single power might be continued, and he would get us out of the difficulty, by altering (for the first time) the point of draught to that in a direct line with the driving wheel, or No. 1; the engine then went on steering quite well, and got out of the watercourse. 8.15. Arrived at Newmarket, went through the town, and left the train in a wide part of the road; returned to town with engine, and placed it in the yard of the "Half Moon," a most awkward place to go into or out of with two horses in a wagon, as the entrance is narrow, crooked, and of a steep ascent. The engine went in and out without the least difficulty, although there were not six inches to spare at two points of a crooked turn. This distance is twenty two miles, in consequence of going round to avoid an insecure bridge on the main road. We started at 10.5 a.m., arrived at 8.15 p.m. ... ... Time 10h. 10m.

Deduct actual stoppages	3.55	
Less stoppages that would have been necessary had tanks existed	0.20	
		3 35
Actual mercantile time		6 35

which is equal to 3 and 4-10ths of a mile per hour for one day. Coal used (including a little coke), 10 cwt. 14 lb., or about half a hundred weight to a mile. The coal was bad, the road generally on a rise, Newmarket being much above Thetford.

Friday, May 15, 6. a.m. In Newmarket. Got up steam and repaired the axles of the threshing machines, which, being of wood, were working badly all the day before. 7.15. Started with the train. 7.56. A hill near the fourth milestone, nearly 1 in 9, the rest of the hill 1 in 12; about 1 furlong in length; not the least difficulty. 2½ miles per hour. Road very good. 8.30. Stopped six-mile bottom for breakfast, filled up water; road good but very undulating; the railway people telegraphed our starting from here up their

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line. The train was diminished in weight by the loss of the agricultural engine of three tons. 9.15. Started across the railway. Road excellent, much down hill; stopped at Bourne bridge for water; there being no convenient place to water, the engine was detached from the train and turned at right angles down an embankment at 1 in 4, then on the bank turned again short to the right into the river, where, the tank being filled, the engine went through the stream and up the other bank into the road, and, backing on to the train, started at 11.33. 12.53. Stopped for dinner at Chesterford, and filled up water. 2.13. Started from Chesterford. 2.50. Stopped at Littlebury to show the engine. 4.18. Newport; stopped for water, backed into a yard for it; stopped four times for horses. 5.3. Went on, stopped very often to fill up water, fearing a want of accommodation. Windmill Hill very long and heavy, 1 in 15 in one place. 8.30. Bishop Stortford; put up for the night; turned off a 15 foot road at right angles with the whole train into the inn yard, which ascended steeply. Stuck fast on a dung heap, the rear wagon still overlaying the turnpike road. Put on double power and took in the whole train, dispersing the dung heap all round; a shout from the bystanders who had made up their minds that she was fast for the night; broke the steering pole and had it fished with iron plates.

Saturday, May 16th.—7.22, a.m.—Left Bishop Stortford. Spillbrook Hill, one in twelve, road broken, engine tended to near-watercourse. Altered point of draughts and went on. 8.20. Stopped to change draughts back again, tightened bolts on engine, and looked it over. Stopped at Harlow Railway bridge, took off engine, and filled up water, took in 12 cwts. of good coal, 20 cwts. having brought us from Newmarket, forty-one miles—less than half a cwt: per mile. Road excellent—Bishop Stortford to Harlow, six miles. Station-master said we had arrived in *half* the time they had allowed us to do it in. Put the drag on to the timber carriage before it had reached the top of the incline. The engine took it all over with ease, notwithstanding the drag. Engine-driver quite acquainted with work and the engine; all went on smoothly. Harboro to Epping, seven miles. 12.20. p.m. Epping. Watered and dined. Road hilly and rough from Harlow, but hard and dry weather, very fine. The road telling on the shoes. The consumption of oil and grease great. 1.37. Started from Epping, taking one passenger, who was anxious to see the engine work. Left the engine at a pond to water, when the men, without orders, put on a new finger in lieu of one broken. Took in water; one tank full had brought us nine miles of very bad road. The road through Epping Forest and into Woodford very bad, no level. Gradients from one in eighteen to one in forty, the road broken up all over, sandy and heavy, with half-settled material (round flint gravel unbroken). 5.20. Started from Woodford. 5.25. At the bottom of the hill in the street engine stopped, and on coming up to it saw two

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teeth broken out of the geared wheel, and the backward shoulder of the shaft saddle broken off beyond the bolts. 5.45. Changed to the double power to ease the saddle, the bolt of the lever of the double power came off. Here I left the train within 200 yards of its destination, which was to be at Stratford. It was supposed the accident was caused by a momentary riding of the shoes, from an improper bend in the new finger; but this was not confirmed by the engine-driver, who must have felt the shock: he only saw the tooth fall, and then the bit of the saddle fall at his feet on the foot-plate. The crank shaft was slightly bent at the same time, yet nothing appeared to derange the motion of the engine. The road was good, and slightly down hill and on a turn. I was looking at it from a short distance, but did not perceive any peculiar motion. The heels and toes showed the effect of eighty-five miles of flint road, and one end of each rail was worn at the corner. The fingers were in some instances indented, but I do not think the actual loss of iron as much as would have been incurred on the shoes of the fourteen horses it would have required to draw the train. There was not any perceptible wear in any other part of the engine. The coals averaged half a hundred weight per mile, and the pace averaged 3½ miles per hour. It would not be well to allow one of those engines to exceed five miles an hour. There was much less difficulty in descending hills and turning corners with a long train than was anticipated.

Bath, May 19th, 1857. W. McAdam.

The experience thus acquired in this—the first experiment of any length that had been undertaken—induced Mr. McAdam to suggest some trifling alterations in the details, in which Mr. Boydell concurred, and the proof thereby afforded of the applicability of the Traction Engine for drawing waggons with ordinary wheels on common roads was considered by all as most satisfactory.

The result of using the Endless Railway applied to waggons or carts, and drawn by animal power, over ground otherwise impassable, is thus described by General Sir W. J. Codrington, Commander-in-Chief in the Crimea, in a communication to the Home Government, of which the following is a copy:—

Camp before Sebastopol, 19th February, 1856.

I saw the Mud Sling Cart used on the occasion referred to. It was during quite a deep, sticky, wet Crimean mud. I understood at the time that the

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95 cwt. gun could not have been moved at all by common means on such ground; and, though an excessively clumsy-looking affair, I saw five horses move it at once on the level, stop at the rise, have two more horses put on, then move again; at a more difficult place two more were added, making in the whole nine horses.

It crossed the railroad, and the little ditches by the side of it.

(Signed) W. J. CODRINGTON, *General Commanding.*

The following is also corroborative of its utility under circumstances of a somewhat similar character:

Royal National Life Boat Institution, 14 *John Street, Adelphi, London, 28th January*, 1856.

GENTLEMEN,—I beg to acquaint you that the life-boat carriage fitted with your Patent Endless Railway was tried on the shingle beach at Dungeness on the 28th and 29th December last, with complete success.

The total weight carried, including that of the carriage itself, was about four tons and a quarter. This was readily drawn at a walking pace by four horses, over the flat parts of the loose soft shingle which abounds in that locality, and over the more uneven parts by six horses.

The rail boards did not sink more than two inches in the shingle on the level portions of the beach, and not choke or clog by the loose stones.

From what I have seen in a former trial with another carriage in the same locality, I feel no doubt that the wheels, without your railway attached, would have sunk twelve or fourteen inches in the shingle, and that the carriage would have required twice as many horses to draw it as with the railway. I am consequently of opinion that your plan is admirably adapted for drawing heavy weights over loose shingle or heavy beaches, and that it will therefore be well suited for the transport of life-boats in such localities.

I am, gentlemen, your faithful servant,

(Signed) J. R. WARD, Commander, R.N.,
Inspector of Life Boats.

Messrs. Boydell and Glasier, Camden Town, London.

For the combination of the two arrangements, namely, the "TRACTION ENGINE and ENDLESS RAILWAY" for the motive power, and the use of the "Endless Railway" on the load moved, the experiment made at Woolwich in the presence of the Committee appointed by Government, at the same time

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as the one quoted before, is thus described in an extract taken from the same source:—

> The second experiment was in hauling a gun of the same size over a marshy bog in the lower part of the Arsenal grounds, a bog too soft to bear the feet of horses when pulling, or even when standing. The wheels of the gun-carriage in this case were furnished with rails, and the engine was yoked to the gun by means of a rope, capable (it was said) of sustaining a strain of 10 tons. This rope was broken by fair pulling several times, owing to abrupt inequalities in the ground which the wheels were run against, and not the best of engineering; but these eventually were both overcome, 2,040 lbs. pressure of steam on both pistons, or 60 lbs. to the square inch, dragging 18 tons triumphantly over the quagmire!—a result which all the artillery-horses in her Majesty's service could not have effected.

With these multiplied proofs of its application and efficiency under so many different circumstances, it is not too much to say, that there are many places in India and elsewhere where the "Traction Engine and Endless Railway" may, with great advantage, supersede the necessity of branch railways, if not altogether, at all events for a very considerable time.

Let us take, for instance, the case suggested by the prospectus of the "North of India Tramroad Company," where it is proposed to make a main line and branches, amounting together to about 300 miles, of which 200 miles belong to the main line, and 100 miles to the branches. If the whole 300 miles can be formed, and the iron procured from England in a short time, of course the 200 miles of main line can be accomplished in proportionably less time, with this advantage, that as the main line is opened up to the several points from which it is intended that the branches shall shoot forth, the branches, for all practical purposes, would be ready at the same time, so that on completing the main line from Shahjehanpoor to Bareilly, 46½ miles, the "Traction Engine and

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ENDLESS RAILWAY," in its fullest application, being used from the former to Futtygurh, 36½ miles, and from the latter to Philibeet, 28½ miles, a communication would be opened simultaneously to the extent of 111½ miles, for which they would only require about 600 tons of rails, at a cost of £9,600 instead of 6,700 tons, at a cost of £107,200. It may also be mentioned, having special reference to the above, that waggons may be so contrived as to run both on the main line of ordinary construction, and also on the "Endless Railway," and so avoiding the necessity of changing the load. The difficulty hitherto of combining railway and road goods traffic in the same waggons, has arisen from the necessity of flanges to the wheels on the former, which would be so objectionable on the latter. Here that difficulty is removed, as the flanges for the wheels on the main line, although not necessary, would be no objection on the "Endless Railway."

Admitting that "speed in forming communications is of more importance to India than speed in travelling on them," the next question is, "How is this grand desideratum best to be obtained?" Unless some better plan can be proposed, I would urge the introduction of the foregoing principle on the serious attention of those more directly interested.

There would be no difficulty either in procuring a sufficient number of traction engines to be made in a very short time, or freight for them and the requisite quantity of iron to India, as the total tonnage would not be large.

A few of the engines should be sent out first under the charge of thoroughly competent persons, who, on their arrival in Calcutta, or other port, should find an establishment ready to receive the engines as they are delivered, and with such aid as, I presume, they will be able to obtain there, to put them together ready for their journey to the interior; and as these

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are finished, others would be arriving requiring the same operation to be gone through.

In the same manner several should be sent together to the interior, also under the charge of competent persons, as by travelling in company, should any casualty or accident occur to any one of them, the others would be near to render assistance, and the drivers daily become more accustomed to their engines.

I would also strongly recommend that only two sizes of engines should be sent out, and that the difference in these should mainly consist in the size of the wheels, so as to increase the speed for the passenger traffic, the greater part of the working parts being exactly the same in all. The economy of such an arrangement in providing the necessary duplicates for repairs, or in case of accident, will be apparent to all, while from the uniformity of construction, the fitters, and also the drivers in the event of changing their engines, would always be up to their work.

The driving of these engines requires but little real mechanical skill or knowledge, and the greater number of those who work the thousands of agricultural engines now in use would be quite competent, with proper care and attention, and a few days' instruction from a duly qualified superintendent, to drive a traction engine. The machinery of the engine itself is similar to the ordinary stationary or portable engines, which have two cylinders, the only peculiarity of the "TRACTION ENGINE and ENDLESS RAILWAY" being in the adaptation of the shoes or Endless Railway to the wheels, the particular effect and operation of which will be better understood by a reference to the annexed diagram and explanation.

The speed at which wheels fitted with the endless railway will travel, and preserve the regularity of their action,

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depends on the size of the wheels, and is about one mile an hour to each foot diameter of the wheel.

Figure 1, shews a wheel fitted with the endless railway.

Figure 2, elevation of one of the shoes, being a sleeper and rail combined.

Figure 3, ground plan of the same.

a, figs. 1, 2, and 3, the rail on which the periphery of the wheel works.

b, figs. 1, 2, and 3, the sleeper, or float, on which the rail is affixed.

c, figs. 1, 2, and 3, the front projection of the sleeper beyond the rail, which acts on going up hill as the toe of the foot.

d, figs. 1, 2, and 3, the back projection, which acts like the heel.

e, in fig. 2, guide bars affixed to sleeper by a side joint, which represent the ankle; the outside of these bars being shaped to the spring of the cycloidal line which the wheel describes.

f, fig. 1, the stops which regulate the descent of the heel of the sleeper, and compensate for the difference between the diameter and circumference of the circle (being as 7 to 22); each rail in length being equal to the radius of the wheel.

g, fig. 2, cycloidal bars or guides, with a pin at the apex by which the shoe is picked up and put down in the course of working.

h, fig. 1, female guides made for the cylindrical bars to work in, which keep the shoes in position, and support them when carried round by the wheel: they consist of front and back; the latter being circled, so as to prevent the pins of the cycloidal bars from getting on the wrong side the guides in their working, and forming a hanging point for the shoes when lifted up. These guide plates are secured to the felloes of the wheel, and the shoes can be taken off and put on at pleasure.

The shoes act entirely independently of each other, and change their position at the top and bottom of the wheel, as will be seen by reference to fig. 1, the heel falling over soon after passing the top by the gravity shoe; thus, as each shoe comes to the bottom of the wheel, the heel is ready to receive it just as it has passed over the preceding shoe; the shoe being quite stationary whilst the wheel passes over it, and forming a complete continuous railway. The friction, depending only upon the weight of the machinery, is not increased by the load, and consequently a heavy load is carried at a greater proportionate advantage than a light one; the draught of loaded carriages upon common wheels over soft ground increases in a compound ratio in proportion to the weight of the load, but it is not so with the endless railway.

The value of "THE TRACTION ENGINE and ENDLESS RAILWAY," whether considered in its power of assisting the

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FIG. 1.

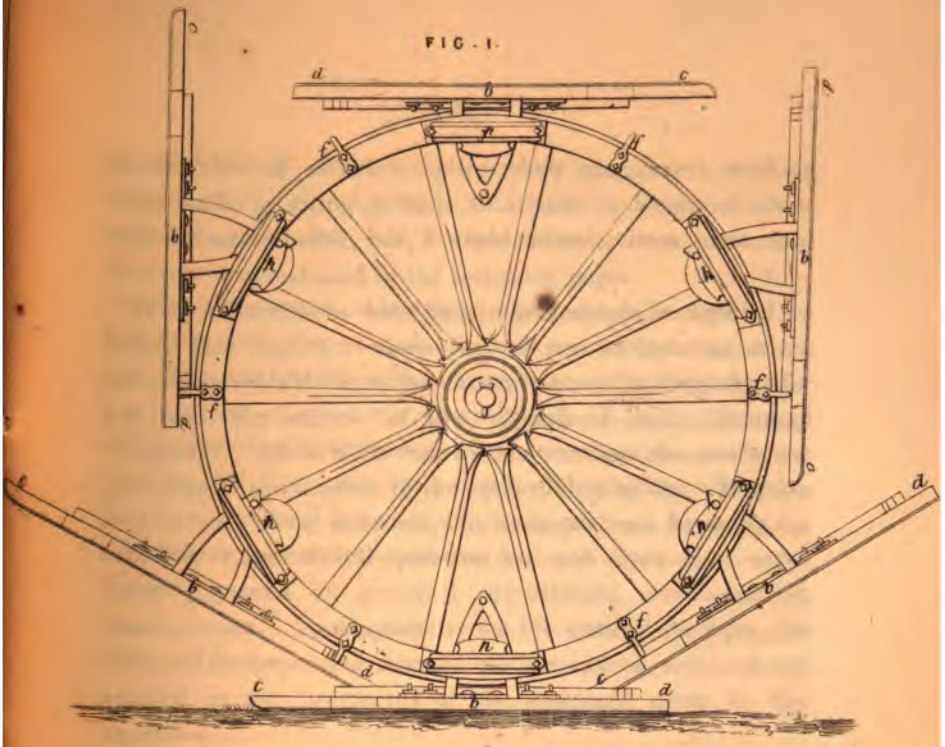


FIG. 2.

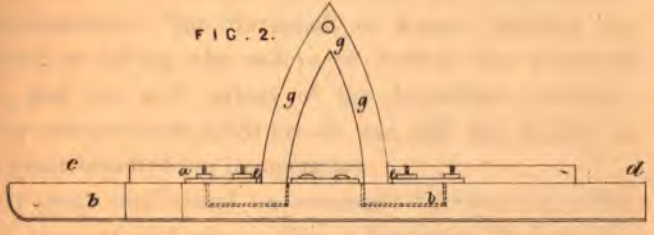
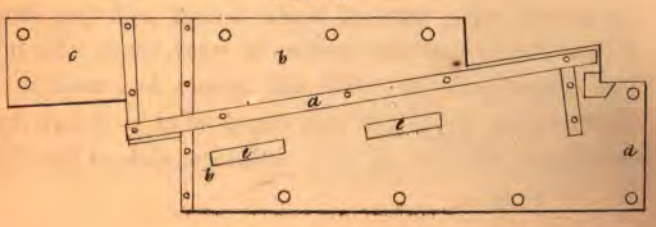


FIG. 3.



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W. T. Lamplugh, Litho. 6 Dyers Buildings, London.

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construction of railways, aiding their economical working when made, or acting as their substitute in localities where they are unattainable, has, I would submit, been most conclusively demonstrated in the foregoing pages.

If my observations have been more especially directed to India, this apparent narrowing of my subject has arisen almost unavoidably from the circumstance of having taken for my text the scheme of the "North of India Tramroad Company." Close adherence to this text has also made me give greater prominence to the applicability of the "Traction Engine" to railway purposes, but its importance for every description of agricultural operation has now been most satisfactorily proved by practical experiments, conducted by practical men. Its adaptability for the work of the farm, the field, and for improving internal communication, will be found detailed in the prospectus of the company given in the appendix.

Both for railway and agricultural purposes, it will be found valuable, not only for India, but for our other colonies, and foreign countries. The Savannah of South America, the table-land of Africa, the valleys of Turkey, the steppes of Russia, and the wide extent of the Australian continent, afford equally available fields for its use, and are certain to derive great benefit from its operation.

Every great mechanical improvement has had its probationary time of difficulty. The "Traction Engine and Endless Railway" has not been exempt from the general rule. Mr. Boydell has had to contend with an amount of difficulty and prejudice, against which few men could have borne up; but after many years of anxious toil, and a great expenditure of time and money, his faith has been proved well founded, and it is to be hoped that his energy, perseverance and skill will be duly rewarded. He has now the satisfaction

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of having the principle of his invention approved by all scientific men, and its commercial value testified by its steadily increasing application to agricultural and other industrial purposes.

As regards the future, I believe that as every day extends the knowledge of its peculiar value, so will each year add largely to its use in all parts of the globe; and, with this belief, I cannot conclude without returning to my text, and entreating all those who are interested in the subject of Mr. Andrew's pamphlet to examine and weigh well the evidence in favour of the "TRACTION ENGINE and ENDLESS RAILWAY, before definitively deciding on their system of tramroads for India.

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POSTSCRIPT.

47, MARK LANE, LONDON, *June* 27th, 1857.

The proof sheets of the foregoing pages were in my hands for correction when the news arrived of the lamentable mutiny and massacre at Delhi. This event manifests with startling emphasis the want of adequate means of internal communication in India. The mode of remedying this defect can no longer be considered as a mere question of commercial expediency, it has become a matter of State necessity. The *Times* of this morning, in an able leader on the Delhi revolt, seizes, with its wonted sagacity, upon the weak point in our Indian Empire—want of speedy intercommunication between the widely-separated seats of British government, and consequent inability to afford one to the other prompt and effective assistance in moments of crisis. It points a practical remedy in the following forcible words:—

"We cannot, however, conclude without urging again upon our rulers, as soon as this revolt is suppressed, the absolute necessity of carrying on the Indian Railway system with greater vigour. *The time has arrived when the power of transporting compact and highly trained bodies of European troops from one point of India to another may be all-important.* In India we are constructing railroads on the expensive English system. Single lines through the jungles and the wilderness, after the cheap American models, could be laid down in a tenth of the time, and at less than a tenth of the expense; and these would enable us to hold possession of the country with an army comparatively small in numerical force."

I agree most heartily with every word the *Times* advances in favour of railway extension in India. The quicker railways are made the more rapidly will that country be elevated in the social scale—the more widely railways are extended the more firmly will our empire over India be assured. But even should

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the Government press forward and give every facility for railway construction, the works, from the various causes enumerated in the foregoing pages, must of necessity be slow of progress, and spread over very many years. Even had we reached this point, yet I fear, far in the future, when the 3,400 miles of railway authorised for India had actually been constructed, there would still remain numberless districts lying out of the main routes, but valuable both for commerce and strategy, which would plead, as Mr. Andrew pleads for Rohilcund, for connection with the great channels of intercourse, to save them from isolation and ruin. This connection the "TRACTION ENGINE and ENDLESS RAILWAY" would afford; and when the trunk lines are completed, we have in it an inexhaustible supply of portable branches, which can transport themselves, or be transported more speedily, over the main line to the agreed point of divergence, and afford ample and inexpensive means of intercourse to districts which could not hope for regular railway communication.

If the Indian Government had now at its command a number of these engines, troops could very quickly be concentrated at Delhi, as five engines with an aggregate of only 50-horse power could transport 1,000 men, fully equipped, at four miles an hour for as many hours in the day as it might be necessary to keep in march. The importance of this in a country situated like India it is impossible to over-estimate. The present emergency will doubtless have passed away before any assistance could be had from this source; but history and human nature alike warn us to expect movements of a similar character at intervals of longer or shorter duration. For those hours of trial, come when they may, the best preparation would be, to have in India a good stock of Traction Engines, which, unlike any other warlike preparation, may be made equally serviceable in peace as in war. It should always be remem-

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bered as a special distinguishing feature of those Engines, that *they carry their own road with them.* And as a pertinent example of the value of this, we may instance that if reinforcements for the Indian Government were now approaching the shores of Hindostan, instead of having to sail round Cape Comorin and up the Bay of Bengal to Calcutta, they might be landed at Kurrachee, and, by means of the Traction Engine, conveyed to Delhi with less land carriage than would be necessary, even after their arrival at Calcutta. The importance of this is self-evident, and affords, if such were needed, another convincing proof that, for purposes of Government, as well as for the requirements of agriculture and commerce, good service to the State may be rendered by the "TRACTION ENGINE and ENDLESS RAILWAY."

APPENDIX A.

Calculations from "Velocity Diagram," showing the extent to which increased velocity absorbs the power of an engine, and thereby diminishes the load.

Conditions.—A good sound road—a straight road—an average side wind—Engine, Tender and Train in good working order.

Tractive Power of Engine, 6,000lbs. at the Rails.

Maximum Load of an Engine, and Tractive Force per Ton, due to increasing velocities.

Tractive Power of Engine 6,000 lbs.

Engine and Tender	Waggons.		Goods.	Total Load.	Tractive Force per Ton.	Velocity in Miles per Hour.
Tons.	No.	Tons.	Tons.	Tons.	lbs.	
35	10	42	87	164	36.6	70
35	14	56	116	207	29.0	60
35	19	76	154	265	22.6	50
35	26	104	208	347	17.3	40
35	31	123	242	400	15.0	35
35	35	140	279	454	13.2	30
35	40	160	320	515	11.6	25
35	47	182	365	582	10.3	20
35	51	204	407	646	9.3	15
35	55	220	443	698	8.6	10
35	58	232	465	732	8.2	7

From Col. Kennedy's "Principles of Railway Construction Analyzed."

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APPENDIX A.

Calculations from "GRAVITY DIAGRAM," showing the extent to which gravity on an incline absorbs the power of an engine, and thereby diminishes the load.

CONDITIONS.—A good sound road—a straight road—an average side wind—Engine, Tender, and Train in good working order.

Tractive Power of Engine 6,000lbs. at the Rails.

Maximum Load of an Engine, and Tractive Force per ton due to a speed of 20 Miles per hour and the annexed ascending Gradients.
Tractive Power of Engine 6,000 lbs.

Engine and Tender	Waggons.		Goods.	Total Load.	Tractive Force per Ton.	Propn. of Goods as compd. to amt. due to level lines.	Gradients.
Tons.	No.	Tons.	Tons.	Tons.	lbs.		
35	2	8	6	49	122.3	.016	1 in 20
35	3	12	23	70	85.0	.06	1 in 30
35	5	20	35	90	66.3	.09	1 in 40
35	6	24	49	108	55.2	.13	1 in 50
35	8	32	59	126	47.7	.16	1 in 60
35	10	40	81	156	38.3	.22	1 in 80
35	13	52	96	183	32.7	.26	1 in 100
35	23	92	184	311	19.3	.50	1 in 250
35	31	124	245	404	14.8	.67	1 in 500
35	35	136	273	444	13.5	.75	1 in 700
35	47	182	365	582	10.3	1.0	Horizontal

From Col. Kennedy's "Principles of Railway Construction Analyzed."

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TRACTION ENGINE & ENDLESS RAILWAY APPARATUS COMPANY, LIMITED.

(BOYDELL'S PATENT)

(OFFICES, No 47 MARK-LANE, LONDON.)

CAPITAL, £120,000, IN 12,000 SHARES OF £10 EACH.

(With Power to increase the Capital.)

DEPOSIT, 10s. PER SHARE.

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THE RIGHT HON. THE LORD MAYOR.
SIR JOHN V. SHELLEY, BART., M.P., Member of the Council of the Royal Agricultural Society.
COLONEL SYKES, M.P., Director and late Chairman of the East India Company.

DIRECTORS.

WILLIAM JAMES GARNETT, Esq., M.P., Bleasdale Tower, Garstang, Lancashire.
FRANCIS HAMILTON, Esq., Friars-place, Acton, Middlesex.
WILLIAM BURNLEY HUME, Esq., 145 Leadenhall-street.
GEORGE WOOD, Esq., Hanger Hill, Middlesex.
(Four more to be chosen from the Shareholders.)

AUDITORS.

(To be chosen from the Shareholders at the First General Meeting.)

BANKERS.

THE BANK OF LONDON, Threadneedle-street and Charing Cross.

SOLICITORS.

MESSRS. TYRRELL, PAINE, AND LAYTON, Guildhall Yard.

SECRETARY.

FREDERICK H. HEMMING, Esq.

BROKERS.

MESSRS. BRAGG AND STOCKDALE, 6 Throgmorton-street, London.
SAMUEL WOODS, Esq., 14 Angel-court, Throgmorton-street, London.
MESSRS. WOODS AND STUBBS, 9 Dale-street, Liverpool.

This Company is formed with Limited Liability, under the provisions of the "Joint Stock Company's Act, 1856," for the purpose of bringing into general use BOYDELL'S PATENT TRACTION ENGINE AND ENDLESS RAILWAY.

For this object, conditional arrangements (which may be ascertained upon application to the Secretary) have been entered into for the purchase of the Patent Right for Great Britain and Ireland and the Channel Islands,

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which, while advantageous to the Shareholders, will make the remuneration for it in a great measure dependent on the success of the undertaking.

This Invention is of national importance, as it removes the only difficulty hitherto experienced in making Steam Traction profitably available, both upon common roads and for agricultural purposes.

The working and the power of the Traction Engine and Endless Railway on common roads have been fully and satisfactorily tested at Woolwich, before a Committee appointed by the Government, and also at other places, and the following important results obtained—viz.: that, on the best ordinary roads, the heaviest loads can be drawn with greater economy than by horse-power; and that, in ascending or descending the steepest hills, or in passing over soft and marshy ground, *where no roads exist*, this Engine and Railway have been found to overcome difficulties which no available amount of horse-power could possibly accomplish.

For Agricultural Operations, the experiments have proved, if possible, even more satisfactory, inasmuch as land ploughed at different places, in the presence of a very large number of practical agriculturists, has been pronounced by them to have been better done than by horses, while the saving of cost has been variously estimated from 40 to 70 per cent., according to the description of the work done, and possessing this great advantage—that, in ploughing on soft or wet ground, *the Endless Railway and Engine do infinitely less harm to the land than the horses' feet in drawing the Ploughs.* Ploughing to a depth almost impossible to accomplish by horses, has been both efficiently and economically performed by means of this Invention.

The ENDLESS RAILWAY, when worked by horses, is scarcely of less importance, as the power requisite to draw waggons and carts fitted with it over soft ground and bad roads will in all cases be immensely diminished, and they can be taken over land where, without it, it would be impossible to draw them by horse power, on account of their sinking up to the axles. Farmers would also be able to cart over their softest lands, at all seasons, without doing injury to it.

The Traction Engine, when fitted to the Endless Railway, possesses all the advantages of the Portable or Stationary Engine, with the great additional one, that it can transport itself where required, without the aid of horses, and draw with it Thrashing Machines, Corn Mills, Scutching Mills, Ploughs, or any other implements intended to be worked by it. Another very important feature of it is, that the Engine passing so smoothly over the Endless Railway, the machinery is liable to far less injury and wear and tear than a Portable Engine drawn on ordinary wheels.

As a feeder to the goods' traffic of railways, by superseding the necessity of short and expensive branch lines, especially in thinly populated districts, the advantages of "The Traction Engine and Endless Railway" can scarcely be overrated.

Traction Engines, with such improvements as have been suggested in the various experiments recently made, are in course of construction for the British Government, and others are nearly completed for private individuals, which will afford additional opportunities of judging of the efficiency and economy with which they may be used.

Applications for licenses have already been received from many of the most eminent engine builders in England, with whom advantageous arrangements can be made for the construction of the Steam Engine portion of the

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apparatus, and consequently the Company will not require to provide capital for that part of the undertaking, but will confine their manufacturing operations to the wheels and distinctive apparatus which constitutes the special feature of the Endless Railway, to which purpose the capital to be raised will be devoted, as also to provide Engines to be hired out either for the farm or for the road.

From these sources, and more particularly from the Royalty to be charged on each Engine or separate set of wheels, a more than usually remunerative return to the Shareholders is confidently anticipated, irrespective of the great and distinctive advantage offered to them in the next paragraph.

With a view to secure the personal co-operation of the Shareholders, it is proposed, in addition to the ordinary participation in the profits of the undertaking, to give to each Shareholder who may purchase or procure orders for engines or wheels fitted with the Endless Railway, one-half of the Royalty accruing to the Company from such orders. This agency-premium to be continued until such time as the proprietor shall have received back the full amount of his stock in the Company. The special advantage which this arrangement will confer upon Shareholders is self-evident. Looking at the extended agency which will thus be called into existence, and at the wide field opened up by the suitability of the invention to aid commercial, agricultural, and industrial enterprise in most countries of the globe, there is every probability that the market even at the first will be large, and that it will be steadily progressive; that the profits will be great, and capable of being immensely increased by the individual exertions of the proprietors.

To enable intending shareholders to make their arrangements, it is proposed to raise the capital in the following manner:—The shares being £10 each, a payment of £2 per share will be required at the time of allotment, of which 10s. per share will be required to be deposited at the time of making the application; the remaining £8 per share will be called up in sums not exceeding £2 per share, and at intervals of not less than three months, but any shareholder may pay up the whole or any part in advance, receiving interest at the rate of 5 per cent. per annum on such sums so advanced until they become, from time to time merged in the calls; and on payment of the whole £10 per share *all further liability ceases*.

For the accommodation of persons residing in the country, on remitting the 10s. per share, by check crossed "*Bank of London*," direct to the Company's Office, No. 47 Mark Lane, with the letter of application, the money will be paid into the banker's for the purpose required, and the banker's receipt forwarded by post to the person making the application.

In the event of the directors allotting less than the whole number applied for, the amount paid in will be appropriated towards the deposit of £2 per share payable on those allotted; and should no allotment be made, the money lodged at the banker's will be forthwith returned, free of charge.

For Prospectuses, Forms of Application for Shares, and further Particulars, apply at the Company's Offices, No. 47 Mark Lane; to Messrs. Tyrrell, Paine, and Layton, solicitors, Guildhall Yard; or to the brokers, Messrs. Bragg and Stockdale, 6 Throgmorton Street, Samuel Woods, Esq., 14 Angel Court, Throgmorton Street, London, and Messrs. Woods and Stubbs, 9 Dale Street, Liverpool.

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